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Teaching New Product Development to Design Led Innovation

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Abstract: *Recently many international tertiary educational programs have capitalised on the value design and business can have upon their interception (Martin, 2009; Brown, 2008; Bruce and Bessant, 2002; Manzini, 2009). This paper discusses the role that two teaching units – New Product Development and Design Led Innovation – play in forming an understanding of commercialisation needed in today's Industrial Design education. These units are taught consecutively in the later years of the Bachelor of Industrial Design program at the Queensland University of Technology, Brisbane, Australia. In this paper, each teaching unit is discussed in detail and then as a conglomerate, in order to form a basis of knowledge students need in order to fully capitalise on the value design has in business, and to produce a more capable Industrial Design graduate of the future.*

Keywords*: Design Led Innovation, Design Education, Industrial Design.*

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1. Introduction

Traditionally, the role design has played within companies has been geared towards the manufacturing and production arena, or as a stylised afterthought. Nowadays, design is increasingly being viewed as a vital and important strategic business resource (Dell'Era, Marchesi and Verganti, 2008) and consequently companies worldwide look to design to help them innovate, differentiate and compete in the global marketplace. This is done by properly employing, carefully evaluating, skillfully managing and soundly implementing design holistically throughout a company's business strategy. The value design possesses, is a different way of thinking, doing things and tackling problems from outside the box. In practice, design is key to greater productivity, whether by way of higher-value products and services, better processes, more effective marketing or simpler structures. Essentially, design is no longer a niche market luxury. It is the most pervasive method for solving problems, ensuring long term sustainability and gaining competitive advantages.

Many international management programs have capitalised on the value design can have upon potential business solutions and strategies (Martin, 2009; Brown, 2008; Bruce and Bessant, 2002) as well as many international design programs introducing designers to business theory and curriculum (Manzini, 2009, see also Stanford D.School). This paper however, presents an approach to integrate design and business innovation into an already existing 'human-centred' Industrial Design program that has been in operation at the educational institution for over thirty years.

The Queensland University of Technology's Industrial Design course philosophy is to educate Industrial Designers to play a leading role in the development of products and systems in our changing environment. It aims to enhance quality of life by ensuring that new technologies are working to the benefit of its users. The curriculum focuses on a human-centred design approach, innovation and systems thinking. The aims and objectives of the program reinforce life-long learning by facilitating the enhancement of graduates' knowledge and skills as part of their career development. It is envisaged that the graduates of this course will be able to contribute to the development of their profession, respond to changes occurring in their environment, and make an immediate and positive contribution to industry, community and the profession.

Undergraduate students enter the Industrial Design program not wanting to become the business leaders of tomorrow but rather, they have a desire to engage more humbly with design, to help people and to

make a difference in the world (Wrigley and Bucolo, 2012). A previous study published by the Authors found that the design profession has seen a gradual shift, from object-centric outcomes to the seeking of systemic solutions, which engage the broader society and have a global setting. Although this shift within the profession is evident, there is resistance from industry, traditional education academics and even students around why designers need to engage in commercialisation, strategic thinking and business model design (Wrigley and Bucolo, 2012).

The bigger issue and focus of this paper, however, is not *why* this content should be taught, but *how* design led innovation and new product development theories can be integrated into a human-centric design course program. At its core, this challenge is about building upon the human centred design skills acquired by Industrial Design students in third and fourth year, and turning these concepts into feasible commercial solutions through business.

The practice of Industrial Design has undergone rapid transformation over the past decade (Wrigley and Bucolo, 2011). As educational institutions attempt to keep up with industry demands, changes in curriculum content and new graduate skills and capabilities are required. In recent years, Industrial Designers, typically, have formed part of a larger eco-system of professionals, which develop innovative sustainable products and services for a wide spectrum of clients. To meet this changing demand, the knowledge and skills of a contemporary Industrial Designer have expanded to compliment their existing expertise in manufacturing design, but to also consider the experiential, business and supporting services of a final design solution. As part of this transformation Industrial Designers are beginning to be brought into a project at an earlier stage and it is expected that they assist in defining a product strategy rather than solely defining a one off solution (Behrendorff, Bucolo and Miller, 2011).

2. New Product Development

New product development is defined as the process by which a new product is brought to market (Ulrich and Eppinger, 2004). One stream of the New Product Development process involves the design activities of idea generation, product design, and manufacturing detail. The other stream of new product development is dependent on market research and marketing analysis. These two streams converge design and business approaches in order to transform knowledge or conceptual ideas into commercialised new products and services as part of a greater strategic focus (Koen, 2004).

Within the realm of New Product Development (NPD) Industrial Designers play a significant role and hold various responsibilities. These roles vary from maker to marketer, but one role that is universal throughout the NPD cycle is the skilled ability to question, re-frame problems and converge and diverge on the solution design at hand. At the same time being able to confidently present a proposal that incorporates good design and good business. Product innovation and the development of new and improved products are crucial to the survival and prosperity of the modern corporation (Bucolo and Matthews, 2011). At its core lies the generation of the ideas and concepts which underpin product and service innovations. Being able to translate these ideas and concepts into commercial opportunities is also a critical step in the product development cycle.

The unit, New Product Development, taught within the Industrial Design course at the Queensland University of Technology, introduces the relationship between product design and commercialisation to third year Industrial Design students. During this process, students are exposed, for the first time, to strategy development, aimed at meeting consumer expectations, whilst achieving corporate objectives.

3. Design Led Innovation

Design Led Innovation, broadly refers to a set of methods which allows the designer to consider and evaluate their design development from multiple perspectives, typically spanning user needs, business requirements and technology demands. The final design solution is not presented as an artifact in isolation, but an integrated product and service concept. As the design profession moves from servicing a manufacturing economy towards a knowledge-based economy, the role of a designer assisting their clients has also evolved and new approaches to design are being developed and implemented. Design Led innovation is a strategy that aims to radically change the emotional and symbolic characteristics of products through a deeper understanding of broader changes in society, culture and technology. Rather than being driven by user needs or technological developments, Design Led Innovation is pushed by a firm's vision about possible new product meanings and languages that could diffuse in society (Verganti, 2008).

Chhatpar (2007) argues that in order to do their job most effectively, designers need to be brought into the innovation process at the very earliest stages. Many companies today still make the mistake of keeping business strategy and design innovation separate. "Typically, marketers conceptualise a new product based on business strategy; the project

team gets input from various areas of the company and creates a business case; and senior executives make a final choice from among the possibilities they're given. Only then does the idea go to the designers" (Chhatpar, 2007:30).

The sequential method above ensures that the product fits within the company strategy, allowing the team to build a general consensus, and gives senior executives an array of options, this unfortunately takes time. Design Led Innovation however, brings designers in at the very beginning of the process, allowing designers to disseminate innovation and creative thinking at the ground level, producing a more innovative solution. As the business case is being developed, prototypes are put into circulation to uncover users' responses and attitudes with the project team, enabling the company to nimbly adjust to changes in market opportunities long before the product concept is set in stone. The Design Led Innovation teaching unit is taught within the Industrial Design program at the Queensland University of Technology and introduces the relationship between business model creation and design to fourth year Industrial Design students.

4. Teaching Theory

Within the New Product Development teaching unit, the aim was to provide students with background knowledge pertaining to management, financial and marketing parameters surrounding the development and commercialisation of consumer products. Lectures were given throughout the semester pertaining to: product classification, service design, competitor analysis, market size and share, intellectual property, path to market strategies, funding sources, manufacturing requirements, return on investment and preparing a business case and pitch.

The aim of the Design Led Innovation unit was to provide students with knowledge pertaining to product integration within various service and system contexts, relevant to Industrial Design. This is imperative due to the fact that professional Industrial Designers frequently need to integrate different contexts and cross discipline boundaries in order to achieve a successful design outcome. Lectures throughout the semester crossed a variety of subjects including: client engagement, market analysis, intellectual property, co-designing business scenarios and design strategies. What differentiates these two units from the traditional human-centred approach to design, is the theory and design outputs (Table 1). The units of New Product Development and Design

Led Innovation require the foundational skills and knowledge taught in the human centred approach to design.

Table 1. *Approach Comparison.*

Approach	*Output*
Human Centred Design	Ergonomic Considerations Usability Requirements Product Aesthetics Context of Product Use
New Product Development	Commerical Viablility Implications Business Context Requirments Competietve Advantages Intellectual Property Protection
Design Led Innovation	Business Model Prototyping Design Thinking Capabilities Value Propositions Deep Customer Insights Strategic Design Briefings

5. New Product Development Project Context

In groups of three, students were required to take a design concept and develop a business case enabling the product to be launched into the market place within an eighteen-month timeframe. The project consisted of developing the design concept through the application of business analysis tools to generate a range of design concepts. Students were also taught business theory, enabling them to critically analyse design alternatives and preferred design options. This was achieved through utilising the tools introduced within this unit, specifically: The product classification matrix, various NPD strategies and SWOT, dynamic and thematic SWOT analysis.

Students were then required to develop a business case for the launch of their new venture. The business case included the launch details, intellectual property protection, business model design, funding requirements and projected returns and risks. This information was then translated into a short professional pitch of the their new venture, delivered to an external panel of experts at the end of the semester.

The student outcome examples presented in this paper (Figures 1-5) were taken from the same group of students progressing through the Industrial Design program (Matthew Buckley, Morgan Beames and Logan Fairchild) who completed the NPD unit in 2010 and the DLI unit in 2011. These images demonstrate their process and progress in the development of these skills and capabilities.

The starting point of this project was to take an original design concept already developed by one of the students and to investigate the

competitive advantage and address the market gap. In this case the students designed a highly portable, flat-packable stand, which reflected the mobility features needed in portable tablet stands. All stands for this device were, to date, still awkward, bulky and extremely non-portable (Figure 1 illustrates this).

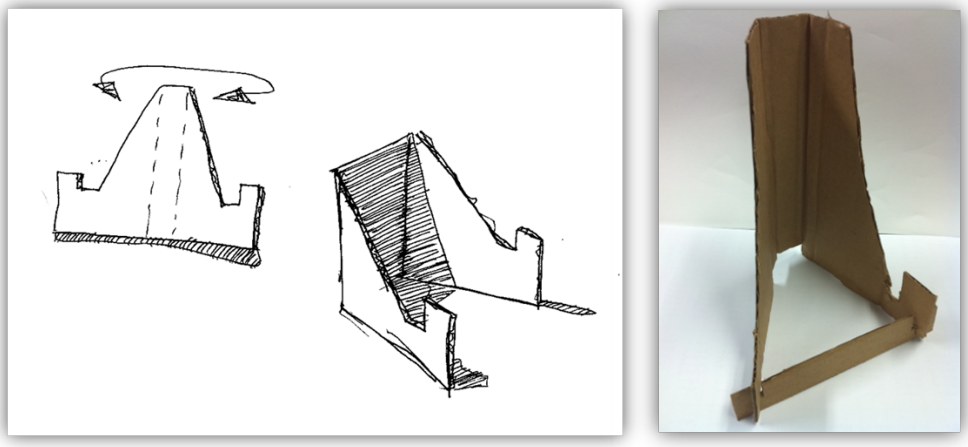

***Figure 1**. Concept Development and Prototyping. Source: Buckley, Beames and Fairchild.*

Initially, the stand was determined to be a multi-part, alloy stand mimicking the form-factor of the current bluetooth keyboard when folded up. This allowed the stands to 'fit into' each other in a bag, reducing space during transportation (Figure 1). It is at this point that the design direction changed based on the product classification matrix tool taught in class, this allowed conceptualisation of the product to move from incremental to radical. They achieved this by leveraging the New Product Development theory and by critically reframing the initial response to the design. They then began experimenting with recyclable, low-cost materials- initially cardboard and finally as recycled polypropylene. The structural elements of polypropylene afforded high structural integrity when the stand was folded and supporting the tablet, but more importantly it provided a large flat surface area on the folded stand that could be die cut very quickly and flatly transported.

The New Product Development approach requires a holistic view and approach to business decisions. This means, not only focussing simply on the 'artefact' outcome, but the broader business solution framework. Keeping this in mind, the design team identified a bootstrapping approach to commercialisation. This was achieved through the flat surface areas of the stand, which the students identified to be uniquely applicable to advertising; as a result, a business-to-business service

model became evident. By undertaking this process, the initial product solution was transformed – from an incremental product to a fully recyclable advertising platform for business to enhance their brand equity while supplying a unique, ubiquitous product (and ultimately a billboard) for the everyday use of their customers (Figure 2). This was a critical point in the design process as it made the design and business scalable and sustainable fairly quickly and easily.

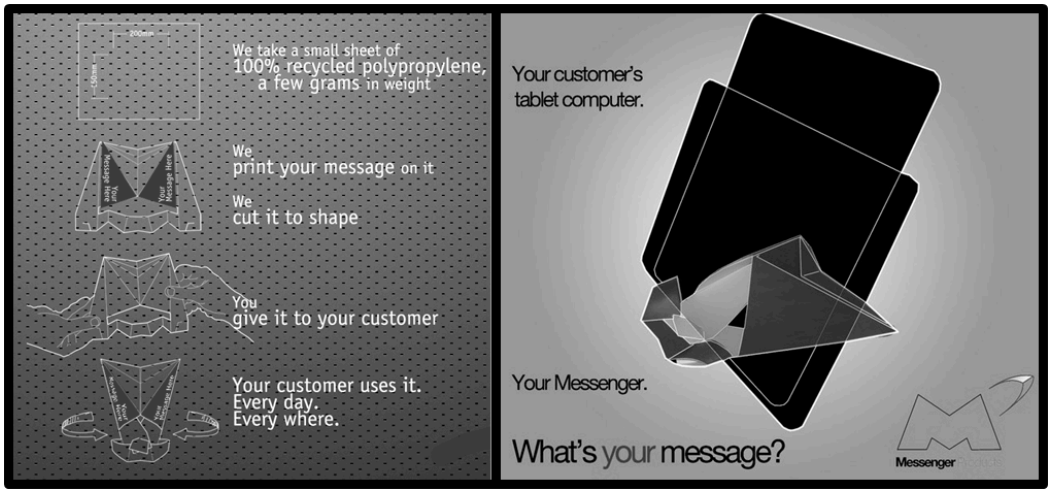

***Figure 2**. Final Design. Source: Buckley, Beames and Fairchild.*

6. Design Led Innovation Project Context

This project focuses on the application of a Design Led Innovation (DLI) approach to the development of an innovative product and service solution, based on an existing technology or research finding. This project was also conducted in groups of three and required the use of an existing proven technology or solid research finding based on a Queensland University of Technology live research project which students had the option of identifying. Students were expected to explore, design and transform a piece of Intellectual Property (IP) into a feasible, sustainable design concept and business opportunity to be launched onto the market within an eighteen-month timeframe. At the conclusion of the project students were required to present enough detail to communicate the product vision to allow the client (research project team and Queensland University of Technology) to determine if they should proceed with the additional product development required (Wrigley and Bucolo, 2011).

The same group of three students partnered with an industry client, an engineer who had developed a unique renewable energy solution,

with the aim to commercialise. The piece of technology developed was a zero-emission, renewable electricity generator. Theory taught during the semester on Design Led Innovation established a different way to think about strategic business management (Bucolo and Matthews, 2011). Within the design led model of innovation there exists a tri-consideration of Business needs, User needs and the Technology's perceived value (Figure 3). Therefore as one-standpoint changes in the commercialization process of the innovation, considerations needed to be made to the other two as they were also impacted.

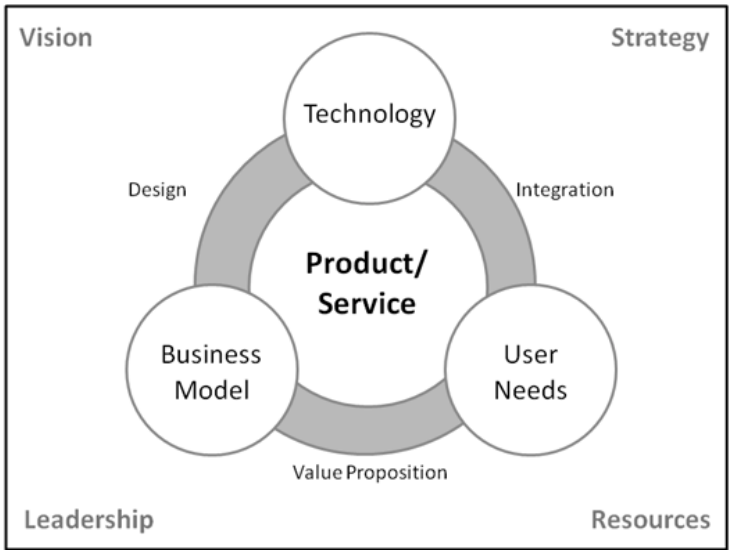

***Figure 3**. Design Led Innovation model.*

Whilst it was important for the students to have a basic understanding of how the generator worked, the focus was appreciating the technologies capabilities and synthesising its possible application. The students challenged the partner's vision for their technology, so that unexpected, radically innovative directions could be prototyped. The first task was to begin matching the technology's capabilities with a wide range of user groups such as relief for emergency power following the Japanese nuclear disaster; remote mining; military and transport systems (Figure 4).

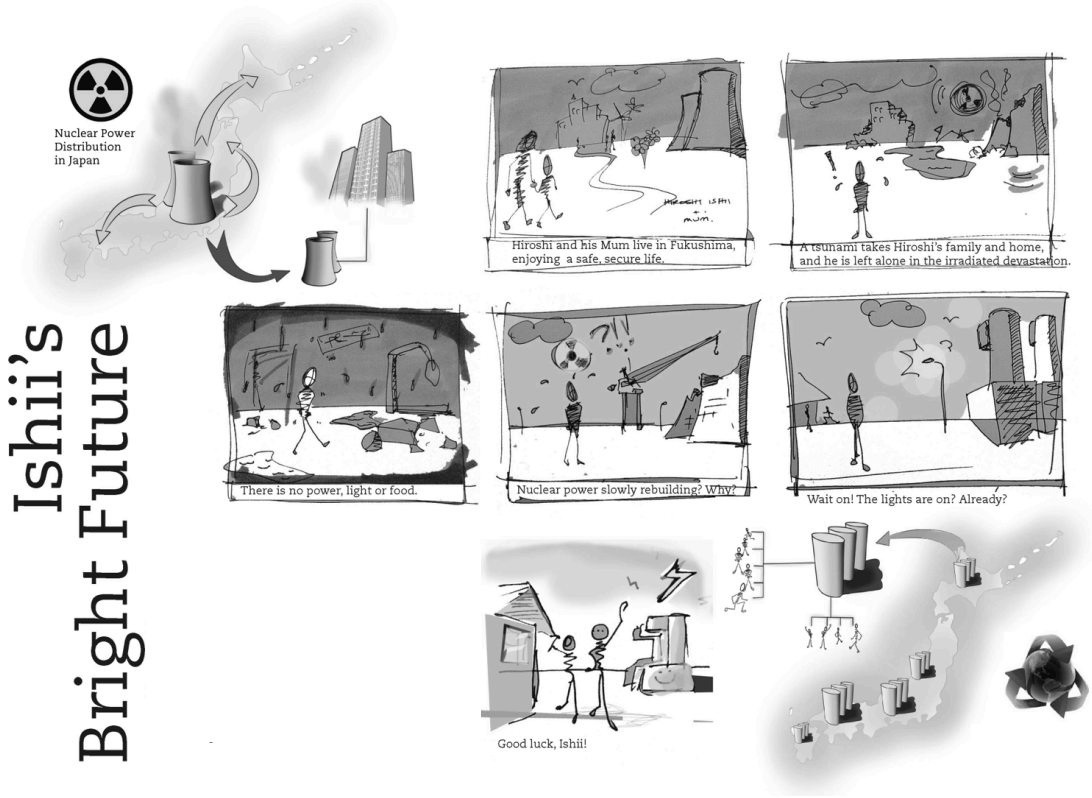

***Figure 4**. Storyboard and problem description. Source: Buckley, Beames and Fairchild*

The guiding philosophy throughout the process of selecting and eliminating user groups was the question – which pairing would create the greatest customer value in the shortest time? Using the business model canvas, various design tools, narratives, story-telling (scenario), value propositions for each market segment were matched and business operations such as distribution channels, key partners and revenue streams where used to build viable business solutions. The inception of a five-point criteria based on DLI theory was used to guide this process. Through the application of this conceptual framework, a model based on energy provision for property developers to on sell to homebuyers, was finally generated and presented to a local city council as the House Land and Energy (HLE) Package (Figure 5).

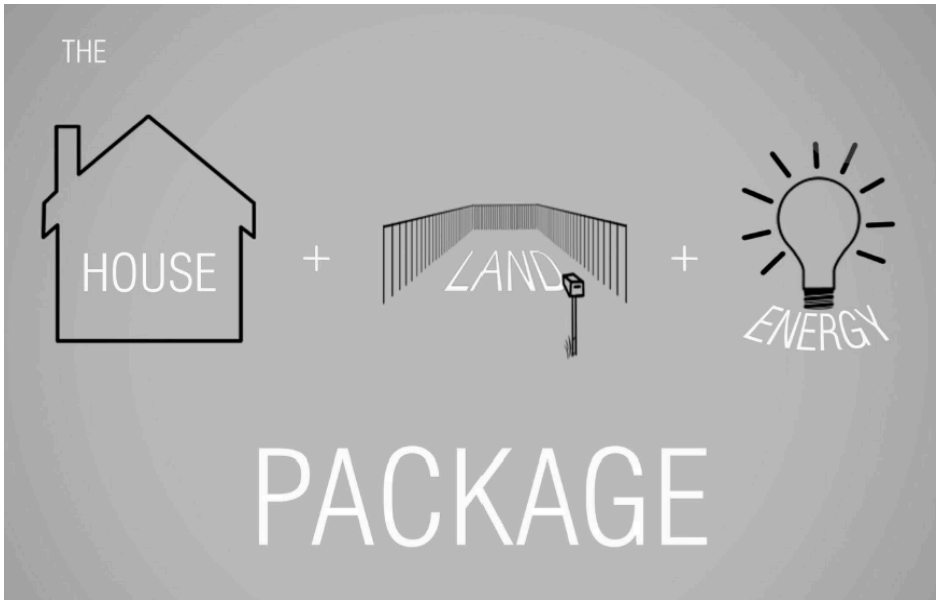

***Figure 4**. Final Design Outcome. Source: Buckley, Beames and Fairchild.*

7. Unit Comparison

The New Product Development unit, which is taught to third year students, combines the fields of product design and business to leverage innovative products through conventional market-driven strategy. Design Led Innovation (DLI) taught in the fourth year, builds on this to introduce an emerging approach to product and service development, by using design-thinking and business model design approaches.

Both units have been developed and run by the Authors for the last four years, during this time both units have undergone an evolution and refinement process. This has occurred each year, allowing for critical reflection by the authors to enable corrections and improvements to the teaching content for the subsequent year.

Table 2, provides a Comparison Summary detailing the differences of the units outlined in this paper – Human Centred Design, New Product Development and Design Led Innovation. Table 2 highlights the development and thought process of the students as well as the acquired skill sets at different points in time throughout their degree. In addition, the column detailing Human Centred Design details the typical human centred design approach to Industrial Design. As a conglomerate, all units form the required knowledge base a graduate Industrial Designer of today should be equipped with to better prepare them for the future.

Table 2: *Comparison Summary*

	Human Centred Design	**New Product Development**	**Design Led Innovation**
Value	Human centred approach	Product centric approach	Business centric approach
Learning Objectives	• Gain a deeper insight into the human centric design process • Demonstrate an understanding of ergonomic data and design principles application • To show feasibility through manufacture • Gain an understating of usability design requirements	• Demonstrate an understanding of new product development processes • Demonstrate understanding of management and economic issues surrounding the introduction of products to the market place • Confidently evaluate a design concept within a commercial framework	• Gain an advanced knowledge of design process and creative thinking • Understand product integration within relevant contexts • Understand the impact of various context to product design • Confidently collaborate with product development teams
Theory	• Ergonomic requirements of design • Human usability considerations • Manufacturing details and analysis	• New product development process • Idea generation • Strategic planning • Introduction to marketing • Product screening and evaluation • Commercialisation and post launch review	• Advanced design process and creative thinking • Knowledge integration within various contexts • Understanding Industrial Designer's role within collaborative projects.
Mode	Hours per week: 4 Lecture: 1, Tutorial: 3	Hours per week: 3 Lecture: 1, Tutorial: 2	Hours per week: 4 Lecture: 1, Tutorial: 3
Approach	The unit consists of lectures and studio workshops.	The unit consists of practical exercises, lectures, discussions and case studies	The unit consists of design studios, lectures, workshops and discussions.
Assessment	Assessment Item 1: *Concept Presentation* Application of theory in a human design approach to the development of a feasible product solution for human user needs Assessment Item 2: *Final Design* Develop and present the final product design concept through the application of usability	Assessment Item 1: *Theory Examination* Assessment Item 2: *Final Design* Develop a product design concept through the application of business analysis tools to generate a range of design concepts. Develop a Business Case for the launch of your new venture as well as the pitch and presentation of the	Assessment Item 1: *Concept Presentation* Application of a design approach to the development of an innovative product and service based on an existing technology. Assessment Item 2: *Final Design and Portfolio* Extend on the selected concept and undertake further design development.

	Human Centred Design	**New Product Development**	**Design Led Innovation**
	and ergonomic requirements	concept to a panel of experts.	Assessment Item 3: *Report* Depending on the role (User Needs, Business or Technology) a written report outing the requirements for the design solution from that role is submitted.
Group Size	4-6 students	3 students	3 students
Group Roles	Each group member took on the same role.	Each group member took on the same role.	Each group member had a Business, Technology and User Needs approach to the design.

8. Unit Evaluation

At the completion of each of the units a unit evaluation was undertaken. This involved the same three students to undertake an interview at the completion of their Industrial Design Degree. During the interview, students were asked to discuss the value they felt these two units had in regards to their overall education. One student commented that “it was good that DLI followed NPD because it took those foundational skills developed in NPD enabling system thinking for DLI so when we were given an industry partner to work with that we had to find a path to market for, having those existing NPD skills first was very beneficial”.

Another student commented that “these two units alone have completely re-shaped what I thought design was, it is far more than producing three dimensional outputs, outside of a commercial context”. All students commented together that “the only way for Industrial Design to move forward is if other sectors learn to appreciate it, and for that to happen we need to communicate with them better, and what better way than to learn to speak their language. NPD and DLI give students a set of communication tools that allows them to go on and understand the business mind and translate that skill effectively, synthesise and bring them together”.

9. Challenges

Even after much success with the development and delivery of both these units over the past four years, there are challenges that still

remain; challenges involving students, staff and industry alike. Both of these units experiment and challenge the traditional role Industrial Designers hold in industry, and as a result, educationally they remain not for everyone. It is evident that DLI theory and application is emerging as a new global trend in Industrial Design education. The authors have embraced this opportunity and capitalised on it by establishing the New Product Development and Design Led Innovation units. Furthermore, running both units consequently over the last four years, has enabled for on-going improvements to unit delivery and subsequent incremental development of unit theory, content and application.

As these skills move from being a niche set to becoming the fundamental knowledge base of an Industrial Designers' education, it becomes all the more important to move forward and accept that at some point all designers will need these skills. The challenge however, is to change the mind-sets of not only the design educators but also that of industry to establish and employ designers in new roles that embody these new skills. Another challenge is the recruitment of diverse disciplines into the Industrial Design class rooms, to teach the external content such as; management, business and marketing. The final challenge is the designers themselves who do not believe they need this knowledge and do not want to become business people. They believe that their role is to help the end user and make life easier and more beneficial for them (Wrigley and Bucolo, 2012). While this might be a worthwhile cause, it is evident that broader, systemic thinking and actions are required to meet the increasing complex challenges that face society today. Simply looking toward user-centric solutions will only address a small component of the system and will only create incremental innovation.

10. Final Remarks

A conglomerate of the units described in this paper is rapidly becoming the foundational skills for Industrial Design graduates all over the world. As these units continue to evolve so must Industrial design education and industry practice. As this paper demonstrated, the greatest challenge is the ability to integrate this curriculum with an already existing Industrial Design course. As illustrated, the foundational human centred design skills are imperative to the success of this evolution in thinking. The end goal is not to convince designers to become business leaders but to integrate the two so that they are able to communicate better with the business world.

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